J M Gill

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TOPOLOGY OF THE GEOMAGNETIC FIELD AT 3 TO 7 EARTH'S RADII ACCORDING TO DATA OF "ELEKTRON-2"

by

A. D. Shevnin

(USSR)

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SUMMARY

Projections have been obtained of perturbed field vectors on a plane parallel to the geomagnetic equator, and on the geomagnetic meridian plane for five satellite convolutions during the period from 10 to 14 February 1964. The behavior of the geomagnetic field for the considered days of low magnetic activity is dependent on local time: on the night side the behavior of the perturbed field basically sustains the ring current hypothesis, while on the morning side, there is noted besides the ring current a blow off toward the night side of the magnetic lines of force and their contraction to the geomagnetic equator plane.

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The AES Elektron-2 was placed into orbit on 30 January 1964 with $11R_e$ apogee on the morning side of the Earth and a 61° inclination to the plane of the geomagnetic equator [1]. The initial satellite's revolution period was 22 hours 40 minutes. Measurements at distances from 3 to 7 R_e were utilized in this work when discussing the topology of the geomagnetic field in the localization region of the ring current. Two such portions are available over each convolution: 1) when the satellite drifts away on the night side of the Earth and 2)during its approaching on the morning side.

The magnetic field was measured by two three-component magnetometers with ± 1200 and $\pm 120\gamma$ ranges for each sensor. The measured field values obtained by the solar sensors for 13-17 convolutions in the period from 10 to 14 February 1964, served alongside with satellite's rotation and orientation parameters as initial material during the conversion of the measured components of the geomagnetic field(**). The matrices of the subsequent transition from measured field components linked with the satellite, to solar-ecliptical and geomagnetic orthogonal systems of coordinates were memorized in a type URAL-2 computer.

(*) TOPOLOGIYA GEOMAGNITNOGO POLYA NA RASTOYANII 3-7 R PO DANNYM "ELEKTRONA-2". (**) private communication by V. V. Beletskiy.

The differences between the values obtained by satellite measurements and the corresponding theoretical field values were computed in the geomagnetic system of coordinates for each field component with six terms of Gauss series. These differences, ΔX_M, ΔY_M, ΔZ_M are shown by vertical segments in Figures 1, а, б, в, where the distances along the satellite orbit in R_e are plotted in abscissa (there were no measurements over the second part of the 17th convolution on 14 February). Taking into account the precision of rotation and orientation parameters of the satellite, the relative error in the differences constituted $\sim$4 percent, which corresponds to $\sim$50γ at 3Re and to $\sim$5γ at 7Re.

From the standpoint of current ring existence one could expect for measurements in the southern hemisphere that $\Delta Y_M = 0$, $\Delta Z_M \leqslant 0$, in all portions of the orbit, ΔX_M passing from negative to positive values as the range from Earth increases. It follows from the examination of Fig.1 that ΔZ_M are negative at close distances, and then positive. The zero transition is noted on the night side of the orbit at 5 – 6 R_e and on the morning side at 4 – 4.5 R_e; ΔY_M are negative on the night side from 3 to 4.5 R_e, being apparently positive at further distances. On the morning side the ΔY_M orbits are mainly negative except for the convolution 16(2)*; on the night side ΔZ_M are negative, except for a few values between 3 and 4 R_e. On the morning side ΔZ_M are positive over 13 – 15 convolutions and have a sign-changing character on the 16(2).

A more descriptive picture is provided by the projections of perturbed field vectors on a plane parallel to the geomagnetic equator (Figs 2 а, б), and the geomagnetic meridian plane (Fig.3 а, б). At the same time the perturbed field was obtained by averaging separate elements of Fig.1 by 0.5 R_e.

In the geomagnetic parallel plane on the night side of the orbit (2300 – – 0030 hours) the projections of perturbed field vectors deflect at close distances toward the side of evening hours and then change their direction toward the after-midnight meridian. Note that these projections are comparable with the computation error, except for the 14th convolution, when a positive perturbation was noted on the ground in the H-component. On the morning side of the orbit (0600 – 0900 hours) the projections of perturbed field vectors over the 13 – 15 convolutions are directed toward the night side of the Earth; they are directed toward the daytime side only in the 16th convolution. The projections of the perturbed field on the geomagnetic meridian plane on the night side (geomagnetic latitude from –13 to –45°) basically agree with the distribution pattern of the ring current field [2, 3], whereas on the morning side of the orbit (Φ from –48 to –28°), field contraction toward the geomagnetic equator plane is present besides the ring current field.

The magnetic activity from 8 to 14 February 1964 is represented in Fig.4a where shown are the planetary index a_p, the mean-hourly deflections of the H-component in Tashkent from the corresponding mean values H_0 of this observatory for five universal quiet days of February 1964, the D_{st}-variation obtained from the Honolulu, Dallas, San Juan, Tbilisi and Tashkent observatories. The horizontal segments under the numerals, beginning with 10 February (which correspond to 13(2)), denote the time of magnetic measurements on the satellite between 3 and 7 R_e.

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* The numerals in parentheses indicate the first or the second part of the (orbit) convolution.

It may be seen from Fig.4 a that minor magnetic storms were observed on 8 – 9 and 12 – 14 February. To the late phase of first storm restoration correspond the 13(1), 13(2) and 14(1) parts of convolutions, and all the remaining measurements discussed were conducted during the storm of 12 – 14 February, disposed as follows: 14(2) at the initial phase of the storm; 15 (1), 15(2) during the main phase of the storm and 16(1), 16(2) and 17(1) during the reduction phase.

The magnetic activity is represented with more detail in Fig.4 , where the deflections of H-, D- and z-elements of the field on the ground from their quiet values are shown for two middle-latitude (Yakutsk, Frederiksberg) and two low-latitude observatories (San Juan, Muntinlup*). The vertical segments to the right denote the scale of deflections, and the horizontal segments below indicate the measurement time on the respective convolutions.

Consideration of Figs 1 – 4 shows, that the behavior of the perturbed field for day with low magnetic activity depends on local time (except for the morning part of the 16th convolution): on the night side the character of perturbed field behavior basically corroborates the ring current hypothesis while on the morning side of the Earth there is noted, besides the ring current, a magnetic line of force blow off toward the night side and their compression toward the plane of the geomagnetic equator. Apparently, the distribution of the perturbed field depends also on geomagnetic latitude [1].

It should be noted that if the differences between the measured and the computed values of the total field ΔT, equal to zero (transition points), were observed in [1] on the night side of the orbit $\sim$ 5R and on the morning side $\sim 6 - 7R_e$, $\boldsymbol{\Delta} X_M = 0$ are respectively disposed at 5 – 6 and 4 – 4.5 R_e, to the distances indicated corresponds a geomagnetic latitude $\Phi \sim -37°$. Therefore, the asymmetry in the disposition of the zero points ΔT and ΔX_M was found to be of opposite character, and this is why it can hardly be referred to the asymmetrical disposition of the ring current in the period from 10 to 14 Feb.1964.

According to data from Explorer-26 [4], the reduction phase of the major magnetic storm of 17 April 1965 was symmetrical, while the ring current was centered near $\sim$3.5R on the equator, with a disintegration constant of $\sim$4 days. The field asymmetry was observed only during the main phase of the storm, and was obviously conditioned by a rapid decay of a large mass of charged particles in the evening and late-afternoon quadrants.

The thorough investigation by Explorer-26 of the position and morphology of the ring current corroborates the conclusion that during minor magnetic storms the ring current is symmetrically disposed around the Earth. It may be considered that according to measurements on Elektron-2, the ring current is disposed symmetrically around the Earth between 3 and 5 R_e for geomagnetic latitudes from 15 to 40°.

A closer disposition of $\Delta X_M = 0$ on the morning side of the orbit by comparison with the night side may be explained by compression of the line of force of the geomagnetic field on the morning side to the geomagnetic equator plane.

(*) [in transliteration]

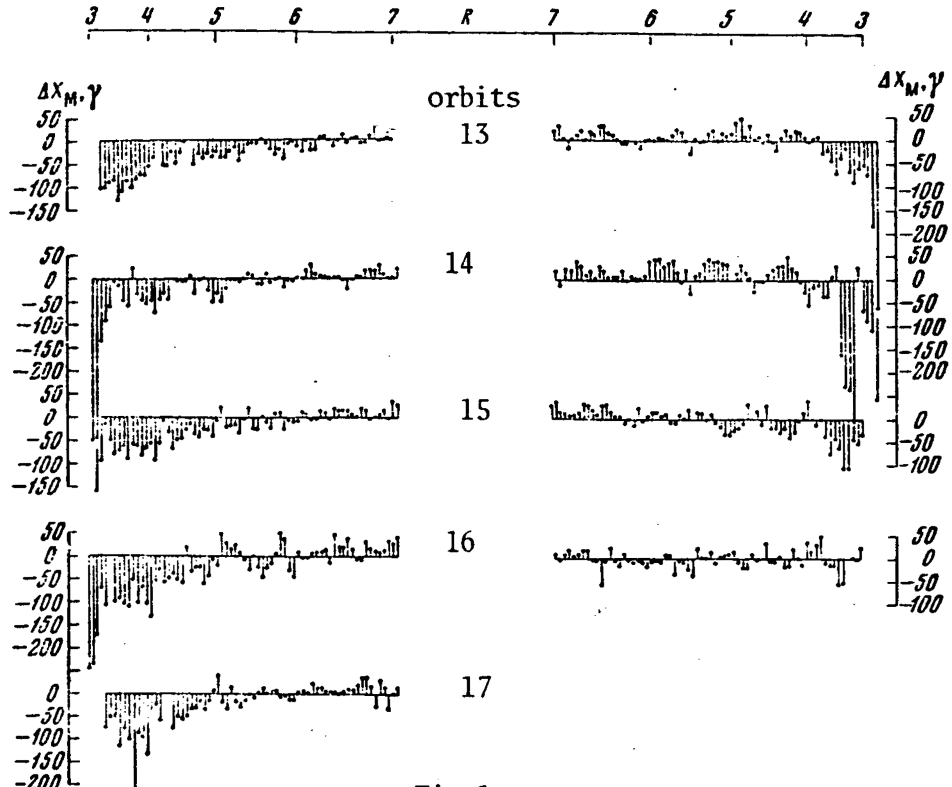
3 4 5 6 7 R 7 6 5 4 3
$\Delta X_M, \gamma$
orbits
13
14
15
16
17
50
0
-50
-100
-150
-200

Fig.1 a

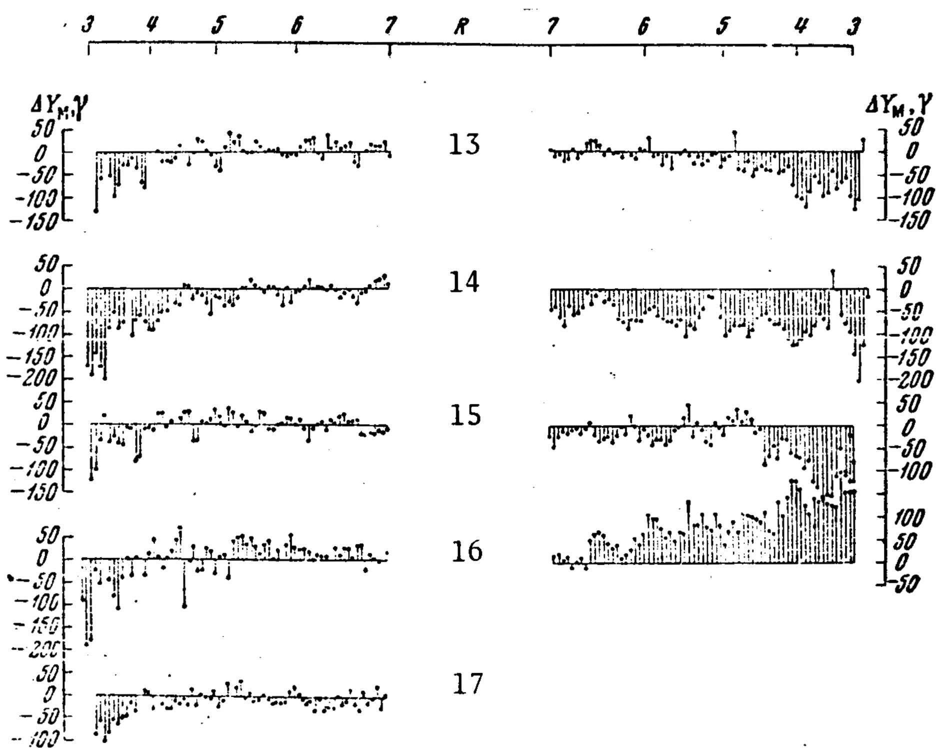
3 4 5 6 7 R 7 6 5 4 3
$\Delta Y_M, \gamma$
13
14
15
16
17
50
0
-50
-100
-150
-200

Fig.1 σ

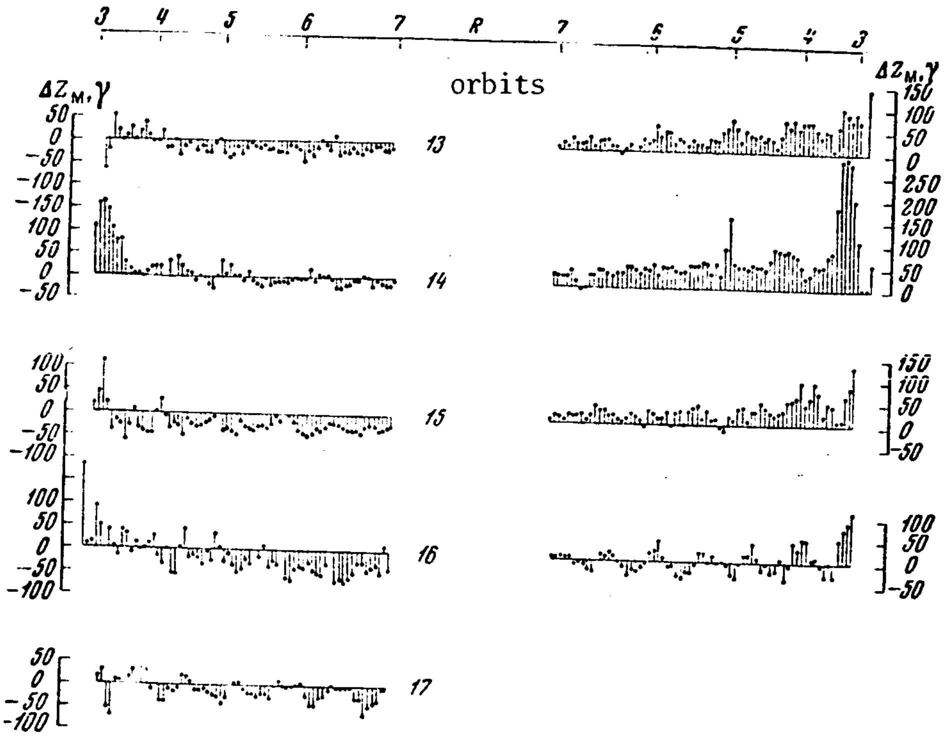

Fig.1 в

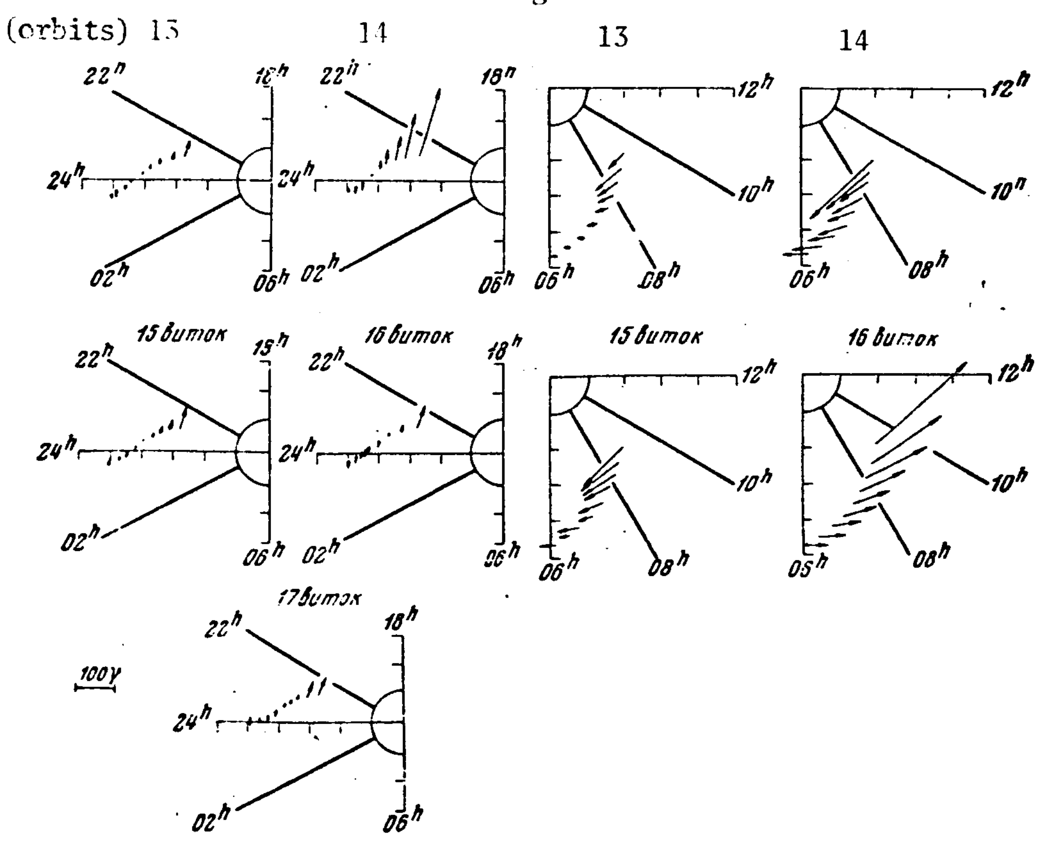

Fig.2, a, σ

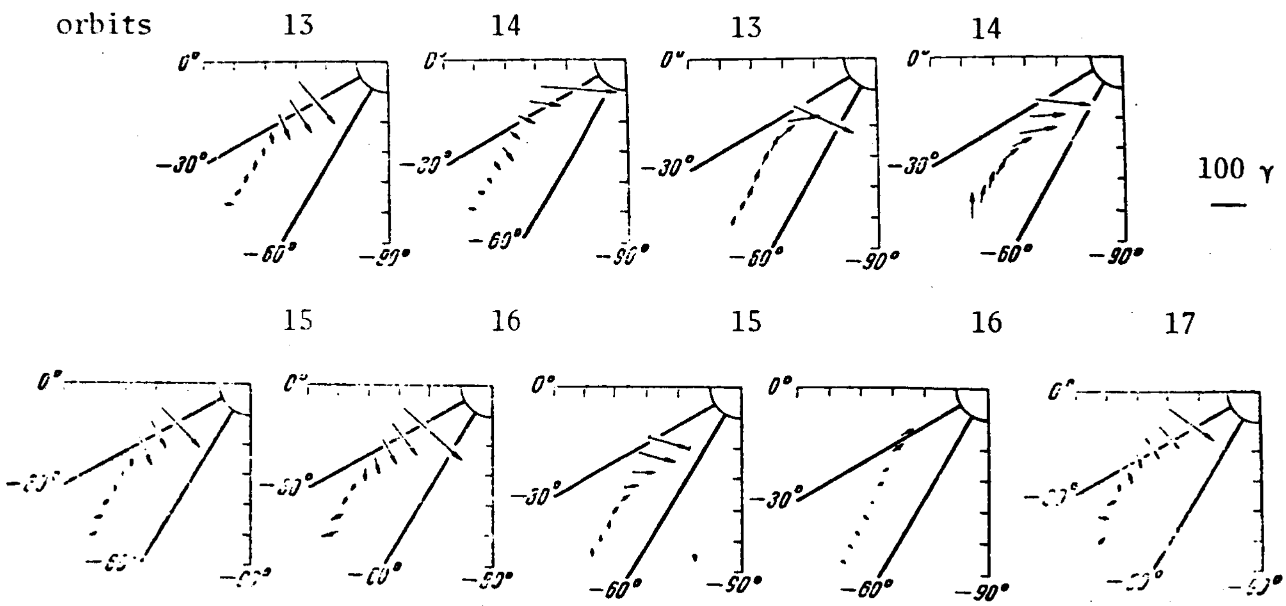

Fig.3 a, σ

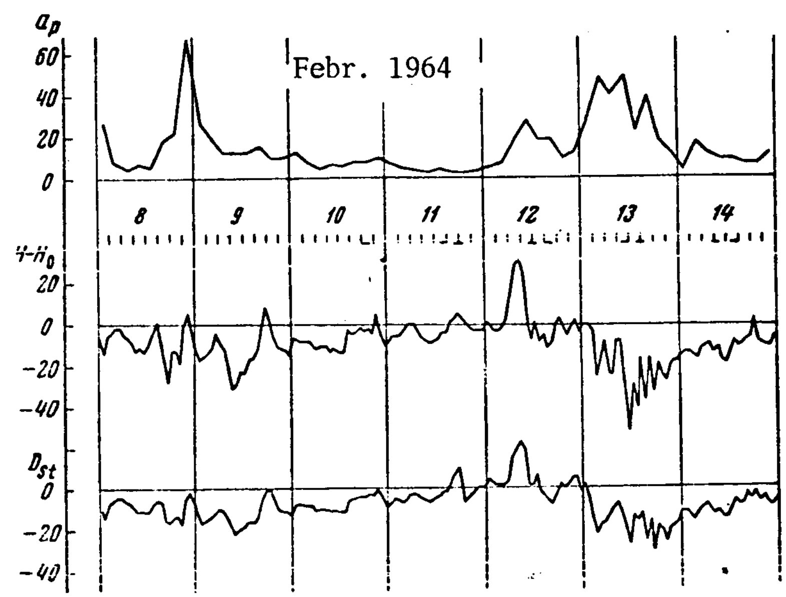

Fig.4 a

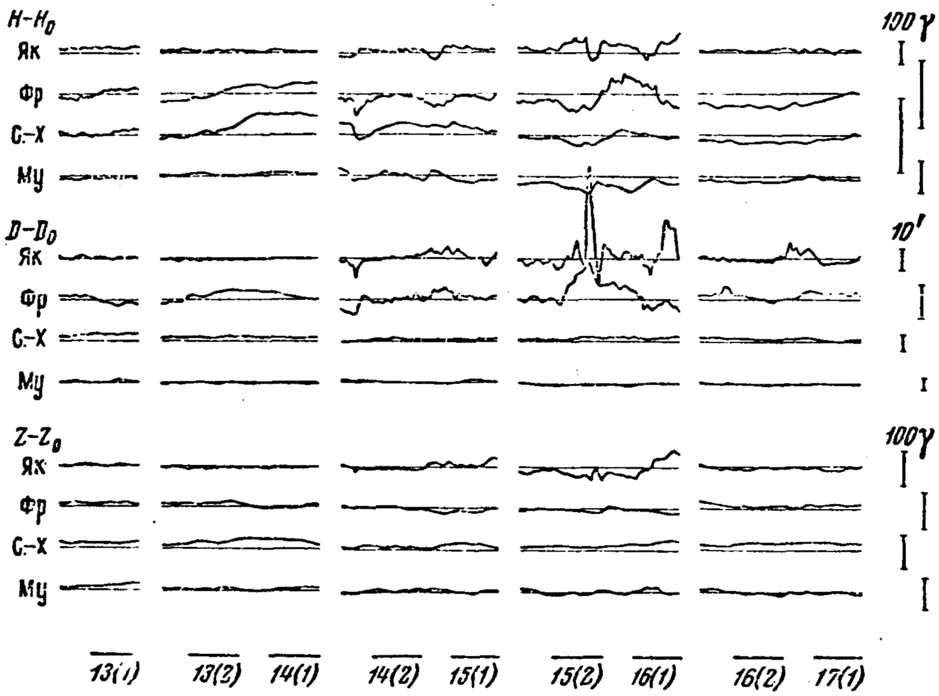

Fig. 4 σ.

which gives additionally $\Delta X_M' > 0$ and $\Delta Z_M' > 0$. This field compression, just as its deflection toward the night side, are apparently due to the action of solar corpuscular streams upon the Earth's magnetosphere.

The behavior of the perturbation field on 16(2) is possibly to some extent connected with the magnetic storm, which, according to College magnetograms, had attained 17 hours prior to that $\Delta H \sim -600\,\gamma$, and during the time of measurements $\sim 150\gamma$.

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*** THE END ***

I Z M I R A N

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VOLT TECHNICAL CORPORATION
1145 19th St. NW.
WASHINGTON D.C. 20036
Telephones: 223-6700; 223-4930.

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